Supplementary Material. Influence of the tank side walls

Here we present the results of numerical simulations for different values of the tank width L. The velocity components and temperature variation fields are presented for the same time moments for ease of comparison. The liquid properties are assumed constant, $Pr = 7.16$. The liquid layer depth is $H = 2.5$ cm. The figures show the whole computational domain.

In the finite-size tanks (figures S1-S5), when the flow reaches the side walls, a weak flow towards the walls (secondary convection cell) is formed below the return flow region and the boundary layer thickness decreases. For $L = 3$ cm (figure S1) this happens earlier. The secondary cell is not observed in simulation for laterally unbounded domain (figure S6). Presence of the side walls results in significant decrease of the horizontal flow velocity in the region, which extends to the distance 1 cm from the wall. The boundary layer thickness grows with the tank width. However, for $L = 12$ cm it is the same as in the case with free boundaries, and for $L = 6$ cm it is only slightly less. The vertical velocity fields are not affected by the tank width, except that when the flow reaches the side walls in the finite-size tanks large downward velocity is observed. In all the considered cases the velocity field at $\tilde{t} = 200$ s is close to the steady state. However, the temperature field evolves much longer. The steady (thermally equilibrated) state is reached in about 4000 s after the heating is initiated, which corresponds to the thermal diffusion time scale H^2/χ. In the finite-size tanks the steady state corresponds to the balance of the heating provided by the heat source and the heat removal through the isothermal bottom of the tank. Thus, the vertical temperature gradient is formed, which is larger in small tanks. In case with free boundaries the heating provided by the heat source is balanced by the advective heat removal in near-surface boundary layer. The similarity solution is constructed in the present study for the boundary layer in laterally unbounded domain, i.e. for the case with free boundaries. However, in the finite-size tanks the velocity distribution away from the walls is essentially the same and the steady-state temperature variation field presents combination of the constructed similarity solution and the vertical temperature gradient related to the influence of the isothermal bottom.

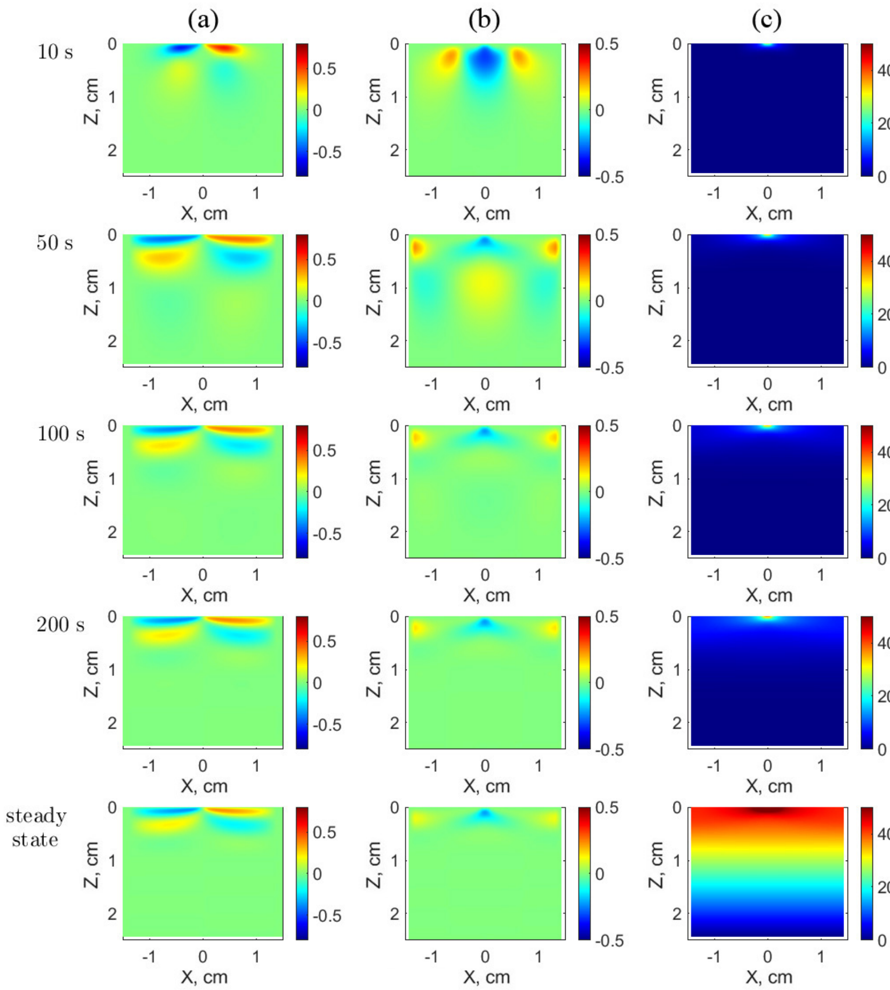

Figure S1: (a) Horizontal velocity (mm/s), (b) vertical velocity (mm/s) and (c) temperature variation (K) fields obtained for $L = 3$ cm.

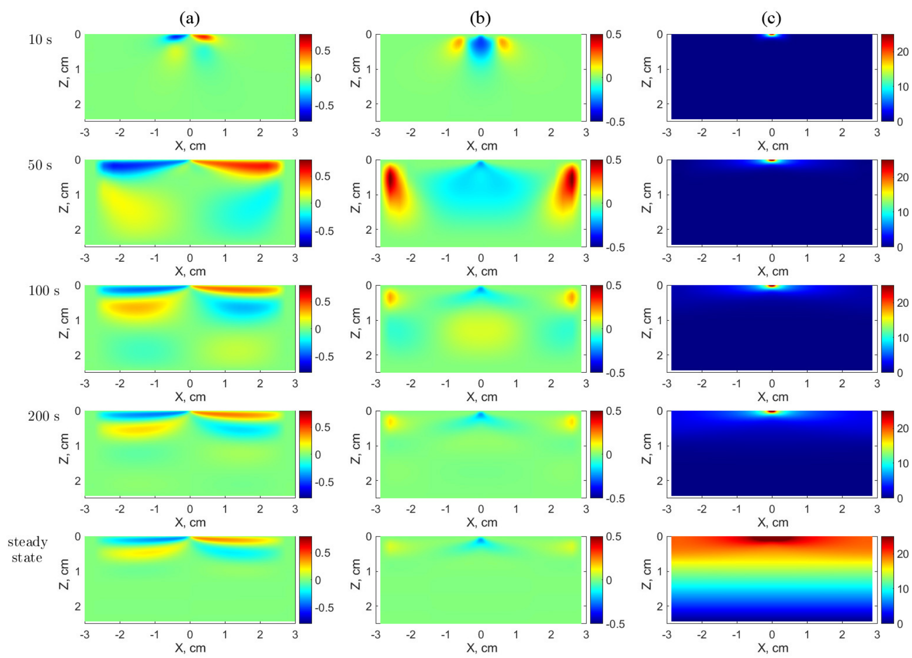

Figure S2: (a) Horizontal velocity (mm/s), (b) vertical velocity (mm/s) and (c) temperature variation (K) fields obtained for $L = 6$ cm.

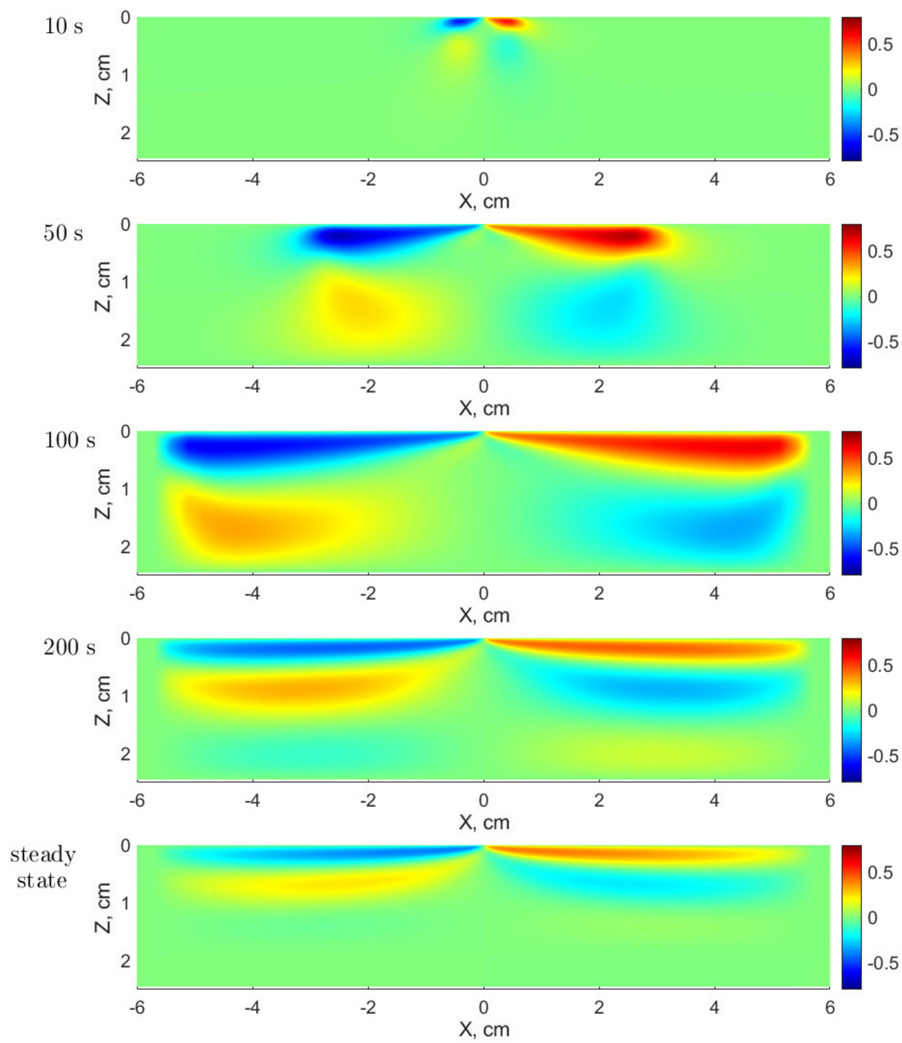

Figure S3: Horizontal velocity (mm/s) fields obtained for $L = 12$ cm.

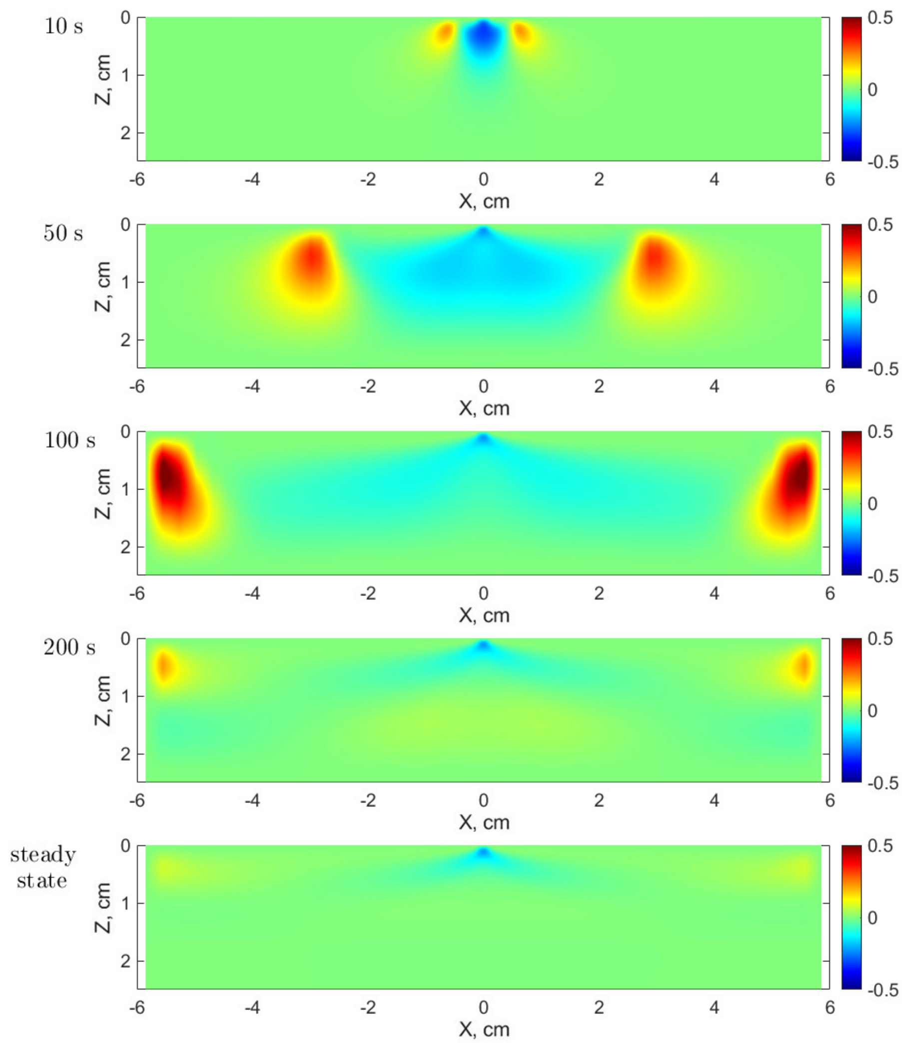

Figure S4: Vertical velocity (mm/s) fields obtained for $L = 12$ cm.

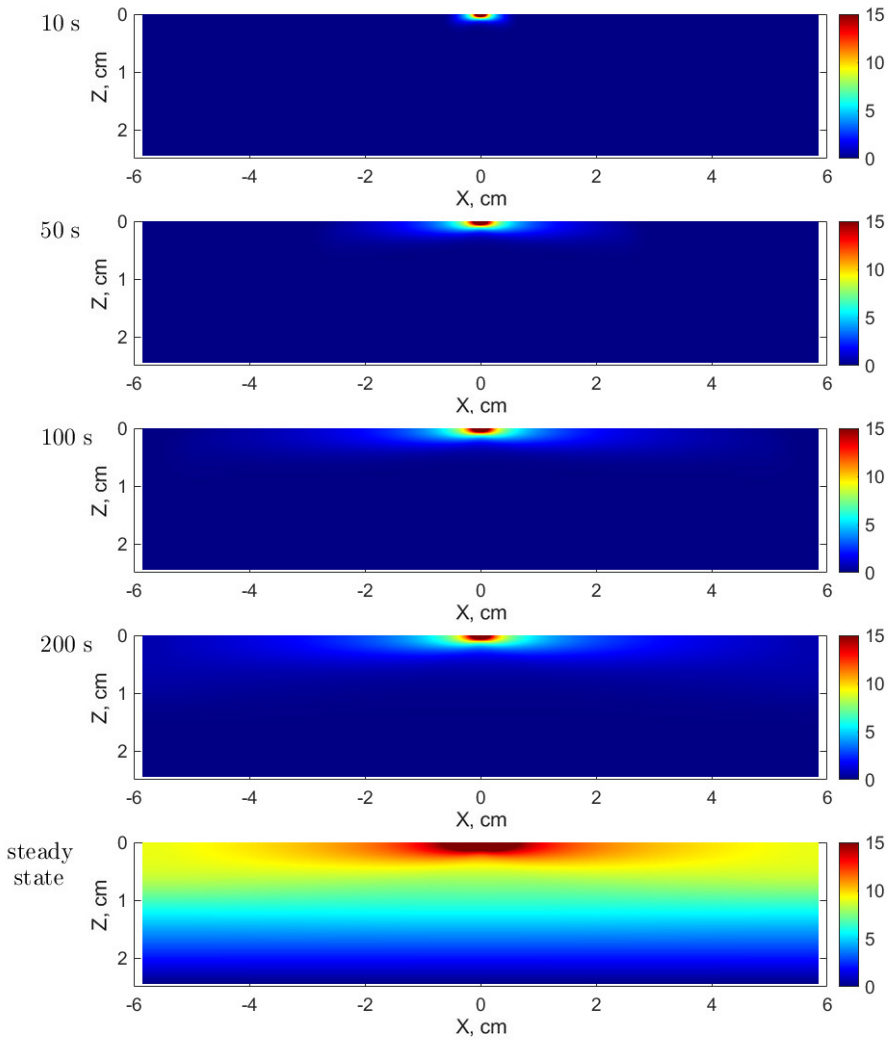

Figure S5: Temperature variation (K) fields obtained for $L = 12$ cm.

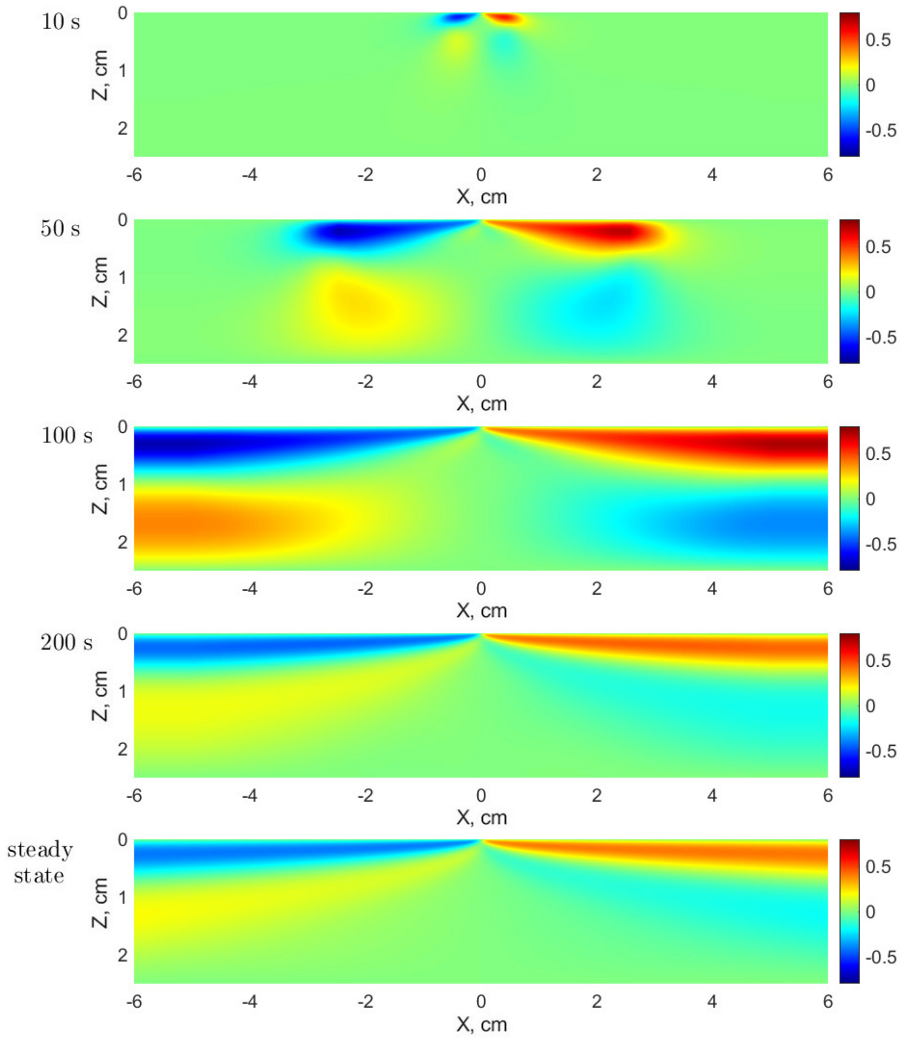

Figure S6: Horizontal velocity (mm/s) fields obtained with free boundaries.

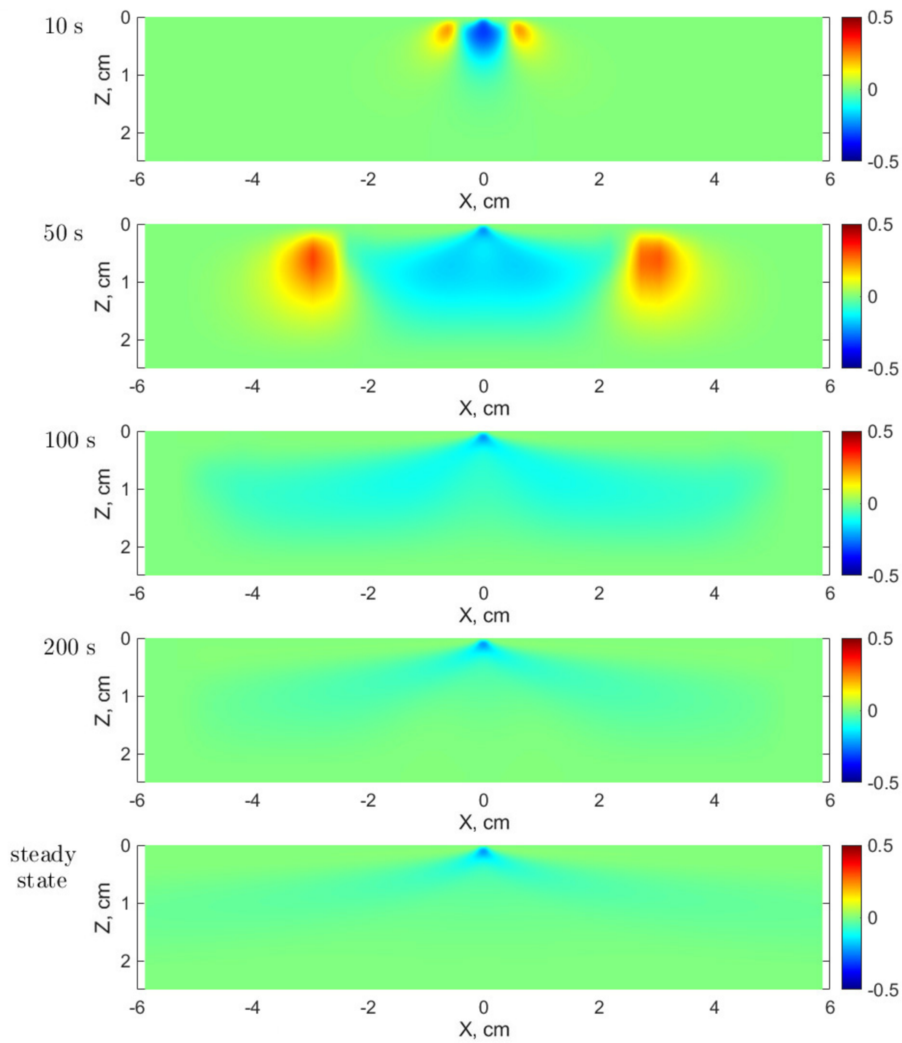

Figure S7: Vertical velocity (mm/s) fields obtained with free boundaries.

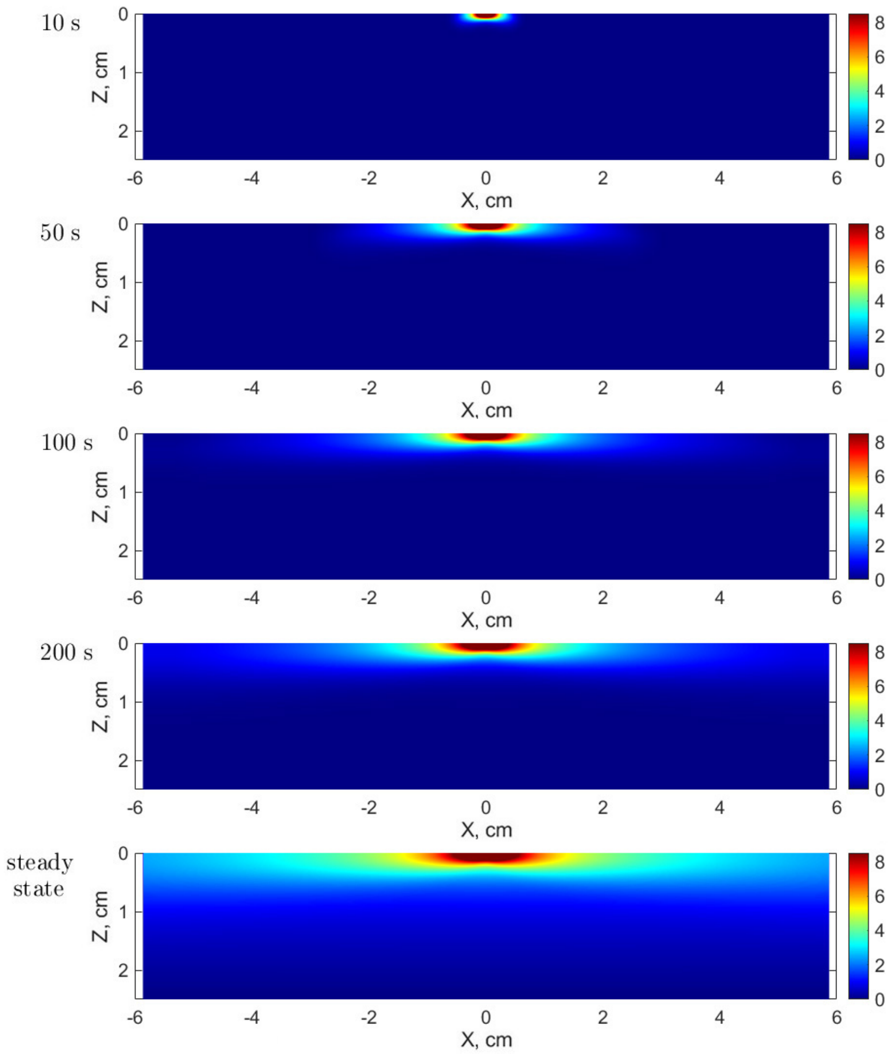

Figure S8: Temperature variation (K) fields obtained with free boundaries.